Methylmercury Control Study Work Plan for the Delta Methylmercury Control Program Implementation Phase I

California Department of Corrections and Rehabilitation

Deuel Vocational Institution

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1. Introduction

As directed in Resolution No. R5-2010-043, Delta Mercury Control Program (DMCP), Deuel Vocational Institution (DVI) is to conduct methylmercury control studies to "evaluate existing control methods and, as needed, develop additional control methods that could be implemented to achieve their methylmercury load and waste load allocations." It should be recognized that DVI is currently meeting their load allocation of 0.021 g/yr as published in Table B in the DMCP. In Table 6.5 in the Sacramento-San Joaquin Delta Estuary TMDL of Methylmercury Staff Report dated April 2010, DVI's annual discharge for Water Years (WY) 2000-2003 was 0.013 g/yr based upon a non-detect concentration of 0.02 ng/L. DVI's current year methylmercury discharge continues to be 0 .013 g/yr with recent monthly effluent reports of methylmercury continuing to be at or below the 0.02 ng/L non-detect concentration. Assuming the same methodology to determine annual methylmercury loading, that is, DVI is discharging methylmercury at concentrations at the non-detect concentration of 0.02 ng/L, DVI continues to discharge 0.013 g/yr.

According to A Review *of Methylmercury and Inorganic Mercury Discharges from NPDES Facilities in California's Central Valley* Staff Report Dated May 2010 (Bosworth, et al. 2010), DVI is discharging an estimated 2.1 grams of total mercury annually. This is consistent with concentrations recorded in their most recent monthly monitoring reports. Additionally it is unclear as to whether or not methylmercury is generated in the collection system and is subsequently removed by the wastewater treatment plant, or if unfavorable conditions exist at DVI for the creation of methylmercury in the first place. Therefore, in support of and compliance with the DMCP, GHD is assisting DVI with Control Study efforts and has prepared this Control Study Workplan on behalf, and with the assistance of, Deuel Vocational Institution.

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2. Problem Statement

Deuel Vocational Institution, as a NPDES permit holder and municipal and industrial waste discharger to the Delta, has been named as a participant in the Delta Mercury Control Program. The percent reduction for the area to which DVI is listed, the San Joaquin River, is from a current load of 528 grams per year to an allocated 195 grams per year. DVI's individual allocation for methylmercury waste load is 0.021 grams per year as published in Table B in Resolution No. R5-2010-0043.

DVI has recently commissioned in September 2010 a newly constructed wastewater treatment plant (WWTP) to replace its existing WWTP. According to Bosworth 2010, "facilities that have some combination of nitrification/denitrification, filtration, and ultraviolet disinfection generally had lower effluent methylmercury concentrations." Employing all these process units, DVI's WWTP is a tertiary treatment plant including biological nutrient removal followed by membrane filtration and UV disinfection. As stated

in the Introduction, DVI is currently in compliance with methylmercury waste load allocations of less than 0.021 g/yr with a discharge of 0.013 g/yr assuming a non-detect concentrations of 0.02 ng/L. The actual methylmercury concentrations could be less than this. A summary of WWTP effluent Methylmercury and Total Mercury concentrations is shown in the table below. It should be noted that DVI was also in compliance during WY00-03, the period during which Delta Estuary TMDL was being examined and established as published in the *Sacramento – San Joaquin Delta Estuary TMDL for Methylmercury*, April 2010 (Wood, et al. 2010). This potentially indicates that the older WWTP at DVI was either also efficient at removing methylmercury from the wastewater influent or that methylmercury was not present at detectable levels in the effluent during the time period reported.

DVI WWTP Effluent Methylmercury and Total Mercury Concentrations		
Reporting Month	Methylmercury Conc. (ng/L)	Total Mercury Conc. (ng/L)
August 2011	ND	ND
September 2011	ND	NR
October 2011	ND	0.78
November 2011	ND	1.96
December 2011	ND	ND
January 2012	ND	ND
February 2012	ND	ND
March 2012	ND	3.30
April 2012	ND	ND
May 2012	.02	ND
June 2012	ND	0.80
July 2012	ND	MD

DVI's new WWTP represents an increase in the performance for all wastewater effluent constituents, not potentially just methylmercury, and it was designed and built as the result of requirements to comply with other NPDES permit limits. Nonetheless, as directed by the DMCP, control studies are required to evaluate existing control methods as well as possible new control methods. Subsequently, the WWTP's

effectiveness at reducing methylmercury from DVI's effluent will be evaluated as an existing control method.

Conversely, what is unclear is exactly how the collection system and WWTP affect methylmercury production and export except to state that they are presently controlled by way of DVI's WWTP. DVI's collection system is relatively small, without satellite agencies, and with full jurisdiction over its operation and maintenance residing with the Institution. It is possible that short residence times, or other environmental conditions, do not support conditions favorable to methylmercury formation. Similarly those conditions may be present, but WWTP process(es) are effectively removing methylmercury prior to discharge. The Control Study aims to answer this question.

3. Objectives

Per the Methylmercury control study guidance, DVI is "to the extent possible, provide objectives that are specific, measureable, and relevant to the TMDL, for: 1) the study activity (i.e. experiments, evaluations, and/or modeling) that will be conducted and 2) application of the study results to your ultimate goal of methylmercury control." DVI is presently in compliance with this ultimate goal by currently discharging below their waste load allocation. Therefore the objectives, as described in the Control Study Workplan Guidance document do not rigidly apply to DVI, insofar that the Institution is not proposing experiments, evaluations, modeling, or other actions or activities that are aimed at further reductions in methylmercury waste loads. In fact any effort to further reduce methylmercury waste loads in the WWTP effluent would be unquantifiable as DVI is already discharging at or below the lower detection limit of 0.02 ng/L. Therefore, DVI is presently in compliance with their waste load allocation as mentioned in Section 2 above. DVI expects continuing compliance with the waste load allocation as capacity expansion, operational changes, or programmatic changes are not planned for the Institution.

With methylmercury in DVI's effluent already below the detection limit, DVI is first proposing to evaluate and understand the effectiveness of their WWTP at removing methylmercury from the plant's influent, provided and assuming that methylmercury is present in the influent in measurable quantities, and second, if methylmercury is present in measureable quantities, determine what location(s) and under what conditions it is created.

Study Objectives

Study Objective 1 is to identify the extent to which inorganic and methylated mercury is created and/or removed by the treatment plant hypothesizing that the WWTP advanced treatment processes both (a) effectively remove methylmercury from DVI's wastewater influent and (b) do not result in methylmercury generation during treatment processes.

DVI's recently commissioned WWTP has improved the water quality of the Institution's wastewater effluent. DVI's WWTP is a tertiary treatment plant including biological nutrient removal followed by membrane filtration and UV disinfection. DVI is currently required per of their NPDES permit to sample effluent for total mercury and methylmercury. However, as there is currently no requirement to sample WWTP influent for total mercury and methylmercury, little is known or can be deduced as to the WWTP's ability or efficiency in treating and/or removing inorganic mercury or methylmercury. Additionally, this objective is concurrent with influent sampling efforts related to understanding and minimizing the discharge of inorganic mercury into the collection system as outlined in the Pollutant Minimization Plan (PMP).

Following upon Study Objective 1 and with the confirmation that methylmercury is present in the WWTP influent, Study Objective 2 is to identify the extent to which inorganic mercury and methylated mercury are present in and throughout the collection system. Primary sources of inorganic mercury at DVI are thought to be the medical and dental facilities at the Institution with secondary locations likely to be the utility tunnels and the boiler building. Study Objective 2 aims to test the hypothesis that Source Control as outlined below in the Control Objectives, the facility's Sewer System Management Plan (SSMP) and the PMP workplan is the primary proposed method of reducing concentration of inorganic mercury in the collection system. However, possibly compounding any accidental or deliberate discharge of mercury is any adverse material condition of the collection system. According to DVI's Sewer System Management Plan, the collection system is comprised of vitrified clay pipe and reinforced concrete pipe. Based on the age and type of collection system, there could potentially be infiltration and inflow (I/I) occurring that may allow for the transport of mercury and methylmercury out of the collection system into the surrounding soils during dry months and subsequently permit reintroduction of inorganic mercury and/or methylmercury back into the system during I/I events occurring during wet months. Additionally, DVI has enacted water usage savings devices which have had both positive and negative effects in relation to the function of the collection system. While overall water usage has been reduced, the lower flows have resulted in higher occurrences of sedimentation in the collection system. This sedimentation may present a possible store of mercury and methylmercury as well as conditions favorable to the continued methylation of inorganic mercury, specifically anaerobic conditions for bacteria and residence time with nutrient rich sediment.

Control Objectives

DVI's control objective would be to identify and quantify the effectiveness of the Pollutant Minimization Plan (PMP) source control measures and BMP's to control discharge of mercury and methylmercury. While largely addressed in DVI's PMP to reduce discharge of mercury into the sewer collection system, as part of the Control Study, information gathered under the Study Objectives should also provide insight into the effectiveness of BMP's and other source control methods identified and enacted as part of the PMP.

4. Mechanisms Underlying the Study

The mechanisms underlying the study are founded upon present quantitative data indicating DVI is already in compliance with their methylmercury waste load allocation. What is not well understood is whether this compliance comes as a result of the recent commissioning of DVI's new WWTP, an absence of methylmercury in DVI's system from creation/introduction, both, or neither.

One possible mechanism for the creation of methylmercury at DVI is sedimentation and/or material condition of the collection system. As previously mentioned in Section 3, DVI has enacted water usage savings devices. While overall domestic water usage has been reduced at the Institution, the lower flows have resulted in higher occurrences of sedimentation in the collection system. This sedimentation may present a possible store of mercury and methylmercury as well as conditions favorable to the continued methylation of inorganic mercury, specifically anaerobic conditions for bacteria and residence time with nutrient rich sediment.

Seasonal dynamics may also play a role if methymercury is detected in the WWTP influent. If there are any compromises to the collection system pipeline, then sedimentation, blockages, I/I, or other issues can be present as well. The possibility of I/I is particularly of interest related to seasonal dynamics. Assuming that the surrounding soils are dry during summer months, it would be possible for wastewater in the collection system and related constituents to be transported into the soil. Then, during wet months when water tables rise and soils become saturated with rainfall, an I/I event could theoretically reintroduce those materials back into the collection system at the same location.

A final study mechanism is to support, or possibly refute, observations and information presented in Wood, et al, 2010 related to the types of WWTP processes that are effective at removing methylmercury. If the proposed influent monitoring indicates the presence of methylmercury with non-detectable levels present in the WWTP effluent, this would indicate that the WWTP is providing methylmercury treatment and/or removal capabilities.

5. Proposed Control Measures

The proposed control measures for the Control Study are:

1. For Study Objective 1, sample WWTP influent for inorganic mercury and methylmercury to determine:
    a. Total mercury and methylmercury concentrations present in the WWTP influent;
    b. Possible creation of methylmercury in DVI's collection system;
    c. Possible creation and likely removal of methylated mercury by the treatment plant;

d. Inorganic and methylmercury removal rate by treatment process;

e. Possible seasonal effects on mercury species loading and discharges at the WWTP specifically, but no exclusive to, wet weather I/I events;

f. Total mercury and methylmercury in the WWTP influent relative to DVI population.

2. Should methylmercury be present in the WWTP influent, sample sediment in the collection system for inorganic and methylmercury. Sediment "Hot Spots" due to insufficient slopes with low velocities that can't keep sedimentation in suspension or areas of pipeline compromise due to root intrusion or other damage where sedimentation or blockages regularly occur are desired locations. Should sampling of the collection system sediment indicate the presence of methylmercury, sample any water, sedimentation, or dry sedimentation that may be wetted in any of the utility tunnels, boiler building, or equipment rooms for inorganic or methylmercury, particularly if it is possible that it may be transported to the collection system.

3. Additional control measures in place, though not directly the result of the Methylmercury PMP or the Control Study, include DVI's Sewer System Management Plan (SSMP). The goal of the SSMP is to provide a plan and schedule to properly manage, operate, and maintain the collection system to reduce and prevent Sanitary Sewer Overflows (SSO). While the goal and implementation of the SSMP does not directly or explicitly speak to control of methylmercury at DVI, a properly maintained collection system is no less important to the overall efficient functioning of the collection and treatment process. When viewed in the context of the methylmercury control study, the SSMP's real benefit is in likely minimizing system blockages and sediment build up thus controlling the creation of methylmercury in the collection system as theorized in Section 4, assuming it is present as determined by influent sampling identified in Section 3.

6. Monitoring and Data Collection Plan

The proposed monitoring and Data Collection Plan is as follows:

1. WWTP influent sampling – monthly, in conjunction with current requirements for total mercury and methylmercury effluent sampling. Upon meeting with the Regional Board on 2 August, a sampling duration of 6 months was agreed by the Regional Board, CDCR, and GHD. The timing of the monthly influent sampling will be concurrent with effluent sampling for total mercury and methylmercury. The timing of six months of sampling will start so that samples are taken during both wet months and dry months. For example, sampling may be started in February and completed in August, thereby enabling the detection of possible seasonal variability. If testing

indicates that methylmercury is non-detect in the influent, then testing will cease. If not, sampling of influent will continue and additional sampling noted in step 2 will be performed. Sampling locations are shown in the DVI WWTP process flow diagram included in Appendix A

2. Collection System sedimentation sampling – If methylmercury is found present in the WWTP influent, a one time, multiple sample of sedimentation in the collection system, utility tunnels, or equipment rooms where mercury is believed to be present will be collected. If possible, several locations along each main sewer branch that originates at a known or believed source of mercury (i.e. medical/dental) should be sampled. As a control, sampling should also occur in sewer mains that do not originate or terminate at locations thought or known to be sources of mercury.

7. Quality Assurance Procedures

Sampling and analysis performed in support of the Control Study will be performed to the same quality standards and procedures as published in Attachment E – Monitoring and Reporting Program (MRP) of DVI's current NPDES permit No. CA0078093. It should be noted that the sampling and analysis proposed under the Control Study Workplan, namely influent total mercury and methylmercury monitoring, are not in fact explicitly called for in DVI's MRP. The MRP however does require and comments on sample type, frequency, sampling procedure, and required analytical test method for total mercury and methylmercury monitoring of the WWTP effluent, EFF-001. These very same procedures shall apply for influent monitoring, the only difference shall be the influent sampling location, which shall be identical to the sampling location required for DVI's influent monitoring.

Should collection system sampling be required, the same methods and procedures will apply, only the locations of sampling will vary. As this sampling will be conducted at several locations throughout the collection system over 1-2 days, additional care will need to be exercised to minimize the possibility of cross contamination of samples. Again, sampling will be in accordance with DVI's MRP, or more specifically US EPA Method 1669, as required in both DVI's MRP and the Control Study Workplan Guidance document.

For methylmercury, aqueous samples will be analyzed using EPA method 1630 with a method of detection limit of 0.02 ng/L or less. For total recoverable mercury, aqueous samples will be analyzed using EPA method 1631 revision E with a detection limit of 0.2 ng/L.

8. Project Evaluation and Data Sharing Plan

Initially, the information that will be gathered will be methylmercury and total mercury, if present, that is sampled in the WWTP influent. As the WWTP effluent is already being sampled for methylmercury and total mercury, the influent data combined with the effluent data will be used primarily in understanding performance of the existing treatment processes at the WWTP related to methylmercury creation, destruction, and potential eventual discharge to the Delta.

If the WWTP influent indicates the presence of methylmercury, the data collected related to the collection system will be evaluated to determine sources of mercury and/or methylmercury at the Institution as well as determining the effectiveness of source control measures and BMPs associated with DVI's PMP efforts. The data collected will be presented in the annual reports required by the PMP.

Appendix A

Process Flow Diagram

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